

# New and Improved GLDAS and NLDAS data sets and data services at HDISC/NASA

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## Introduction

Terrestrial hydrological variables are important in global hydrology, climate, and carbon cycle studies. Generating global fields of these variables, however, is still a challenge. The goal of a land data assimilation system (LDAS) is to ingest satellite- and ground-based observational data products, using advanced land surface modeling and data assimilation techniques, in order to generate optimal fields of land surface states and fluxes data and, thereby, facilitate hydrology and climate modeling, research, and forecast.

## GLDAS and NLDAS Data at HDISC/NASA

### NLDAS: North American Land Data Assimilation System

### GLDAS: Global Land Data Assimilation System

NLDAS and GLDAS data are produced by specific instances of the Land Information System (LIS) software framework for high-performance land-surface modeling and data assimilation. LIS is developed by the Hydrological Sciences Branch at NASA Goddard Space Flight Center. NLDAS is a collaboration project between several groups (NOAA/NCEP/EMC, NASA/GSFC, Princeton Univ., Univ. of Washington, NOAA/OHD, and NOAA/NCEP/CPC) and is a core project of NOAA/CPA. GLDAS is supported by the NASA Energy and Water cycle Study (NEWS). To date, both NLDAS and GLDAS have produced more than 30 years (1979 to present) of quality-controlled, spatially and temporally consistent, land-surface model data.

	NLDAS	GLDAS
Content	Water and energy budget data, forcing data	
Spatial coverage	Conterminous US, parts of southern Canada and northern Mexico	All land north of 60° South
Spatial resolution	0.125°	0.25° and 1.0°
Temporal coverage	Phase-2: Jan. 1, 1979 – present <b>Phase-1: Aug. 1, 1996 - Dec. 31, 2007</b>	Version-1 1.0°: Jan. 1, 1979 - present 0.25°: Feb. 24, 2000 - present <b>Version-2: Jan. 1, 1948 - present</b>
Temporal resolution	Hourly and monthly	3-hourly and monthly
Forcing	Multiple data sets derived from satellite measurements, radar estimation, precipitation gauges, and atmospheric analyses	Multiple data sets derived from satellite measurements and atmospheric analyses
Land surface models	Mosaic, Noah, SAC, VIC	CLM, Mosaic, Noah, VIC
Output format	GRIBdd Binary (GRIB)	
Elevation definition	GTOPO 30	
Vegetation definition	University of Maryland, 1 km	

## NLDAS and GLDAS Data Access

Hydrology Data Holdings: <http://disc.gsfc.nasa.gov/hydrology/data-holdings>

Data Type (Short Name)	Description	FTP	GDS	Mirador
NLDAS-1 0.125 degree, North America				
NLDAS_FOAH0125_H001	Hourly forcing	✓	✓	✓
NLDAS-2 0.125 degree, North America				
NLDAS_FORA0125_H002	Hourly primary forcing	✓	✓	✓
NLDAS_FORB0125_H002	Hourly secondary forcing	✓	✓	✓
NLDAS_MOSA0125_H002	Hourly Mosaic	✓	✓	✓
GLDAS-2 1.0 degree, Global				
GLDAS_NOAH10_3H_E1.002	3 hourly Noah experiment 1	✓	✓	✓
GLDAS_NOAH10_M_E1.002	Monthly Noah experiment 1	✓	✓	✓
GLDAS-1 0.25 degree, Global				
GLDAS_NOAH025SUBP_3H	3 hourly Noah	✓	✓	✓
GLDAS_NOAH025_M	Monthly Noah	✓	✓	✓
GLDAS-1 1.0 degree, Global				
GLDAS_CLM10SUBP_3H	3 hourly CLM	✓	✓	✓
GLDAS_CLM10_M	Monthly CLM	✓	✓	✓
GLDAS_MOS10SUBP_3H	3 hourly Mosaic	✓	✓	✓
GLDAS_MOS10_M	Monthly Mosaic	✓	✓	✓
GLDAS_NOAH10SUBP_3H	3 hourly Noah	✓	✓	✓
GLDAS_NOAH10_M	Monthly Noah	✓	✓	✓
GLDAS_VIC10_3H	3 hourly VIC	✓	✓	✓
GLDAS_VIC10_M	Monthly VIC	✓	✓	✓

### Three ways to access the data

#### ➤ Mirador searching and downloading

- Keyword searching
- Navigation based on Projects
- Navigation based on Science Areas Data Services

#### ➤ Parameter and spatial subsetting

- Parameter and spatial subsetting
- Format conversion

#### ➤ GrADS Data Server (GDS) accesses

- Parameter and spatial subsetting
  - Any operation that can be expressed in a single GrADS expression.
- Output Types: Binary, ASCII, Image

#### ➤ ftp downloading

- Simple and fast
- Navigation based on data products, years, and Julian dates.

## What's New about NLDAS and GLDAS Data

### NLDAS Phase I (NLDAS-1) Forcing data product

The 30-year hourly 0.125 degree resolution NLDAS Phase 2 (NLDAS-2) data were released at the end of 2009 and continue to be produced with a typically 2-4 day lag from the present. Additionally, the **NLDAS Phase 1 data (1996 – 2007)** were recently added to the GES DISC archives and released to the public, to continue to serve users of NLDAS-1 data and allow easier comparisons between the two phases of NLDAS.

### GLDAS Version 2 (GLDAS-2)

#### ➤ Motivations:

- Create more climatologically consistent data sets
- Upgrade the LSMs versions

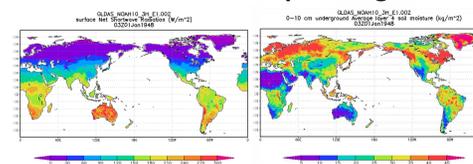
#### ➤ Enhancements

- Use of the global meteorological forcing data set from Princeton University (Sheffield et al, 2006)
- Initialization of soil moisture over desert
- Updated model specific parameter files
- Advanced snow assimilation scheme (in Noah0.25)

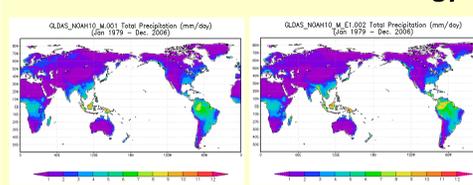
#### ➤ Major differences between GLDAS-2 & GLDAS-1

- By using the Princeton forcing data sets, GLDAS-2 temporal coverage is extended back to 1948. In GLDAS-1, forcing sources switched several times throughout the record from 1979 to present, which introduced unnatural trends and exhibited highly uncertain forcing fields in 1995-1997.
- GLDAS-2 has two streams of simulations:
  - Princeton-based from 1948 up to present
  - Observation-based from 2001 to present
- GLDAS-2 has multiple experiments for Noah model.

### GLDAS-2 sample images



### GLDAS-1 and GLDAS-2 Climatology



Mean total precipitation fields (surface rainfall + surface snowfall) from monthly GLDAS-1 Noah10 (left) and GLDAS-2 Noah10 E1 (right) over 1979 to 2006.

### Updates to each LSM are summarized in the table below.

Model - resolution	GLDAS-1	GLDAS-2	Remarks
NOAH_1.0	Version 2.7	Version 2.7.1	Updated model parameters that specify the initial soil temperature
CLM_1.0	Version 2.0	Version 3.5	Used MODIS based parameter data sets, stand alone
VIC_1.0	Water balance mode	Energy balance mode	Includes all variables
Catchment_1.0	Mosaic model	Catchment	Model switch
NOAH_0.25	Version 2.7, Snow DA: direct insertion	Version 2.7.1, Snow DA: forward-looking	Updated bottom temperature

More information about GLDAS and NLDAS and model data validation can be found at Land Data Assimilation Systems Web site at <http://ldas.gsfc.nasa.gov/nldas/>.

GLDAS-2 Data access: <http://disc.gsfc.nasa.gov/hydrology/data-holdings>

## Giovanni: Online Visualization and Analysis

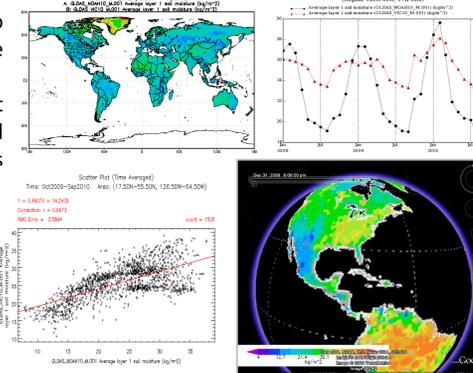
[http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance\\_id=GLDAS10\\_M](http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=GLDAS10_M)

Giovanni provides a simple and intuitive way to visualize, analyze, and access Earth science remote sensing data online.

GLDAS Giovanni allows users to simply select one or more parameters, spatial and temporal ranges, and a visualization function, and returns in image, HDF, NetCDF, ASCII, or KML format.

### Visualization types in GLDAS Giovanni

- Lat-Lon map, Time-averaged
- Animation
- Lat-Lon map, Time-averaged
- Correlation map
- Lat-Lon map of time-averaged differences
- Scatter plot
- Scatter plot, Time-averaged
- Time series



Coming soon:  
Giovanni for GLDAS 3-hourly and NLDAS hourly data.

## Application Examples

### GLDAS improves sub-seasonal weather forecasts

Estimates of land surface states (e.g., soil moisture, surface temperature) produced by GLDAS can be used to initialize short term and seasonal numerical weather prediction systems. Precipitation and temperature forecasts are sensitive to land surface conditions at the start of the prediction period. GLDAS output can be used to initialize the land surface states and hence improve forecast accuracy. [http://disc.sci.gsfc.nasa.gov/hydrology/additional/science-focus/seasonal\\_forecast.shtml](http://disc.sci.gsfc.nasa.gov/hydrology/additional/science-focus/seasonal_forecast.shtml)

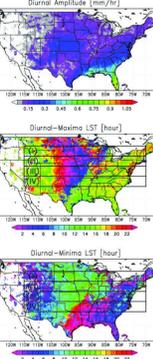
### Diurnal cycle of summertime precipitation from NLDAS data products

Matsui, T., D. Mocko et al. examined diurnal cycles of summertime rainfall rates over the conterminous United States, using a 10-year climatology (1998-2007) of assimilated hourly rain gauge data from NLDAS-2. The results clearly indicate:

- A dramatic but gradual change of the diurnal peak of precipitation from the Rocky Mountains (early afternoon) to the Great Plains (early morning).
- Well-defined regions of rainfall propagation over the Great Plains are identified, as well as an afternoon maximum area over the southern and eastern portions of the United States.

A Science Focus article on this work can be found in the GES DISC hydrology portal, <http://disc.sci.gsfc.nasa.gov/hydrology/additional/science-focus/nldas-diurnal-cycle>.

Matsui, T., D. Mocko, M.-I. Lee, W.-K. Tao, M. J. Suarez, and R. A. Pielke Sr. (2010) Ten-year climatology of summertime diurnal rainfall rate over the conterminous U.S. *Geophysical Research Letters*, **37**, L13807, doi:10.1029/2010 GL044139

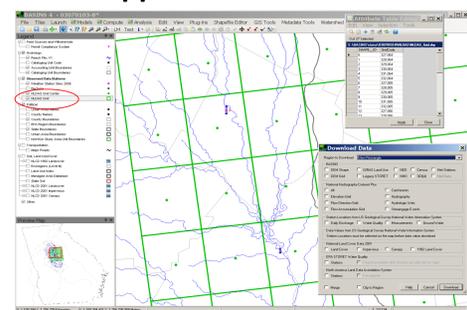


### NLDAS data improve the water quality model performance

Joseph Nigro and his colleagues investigated whether the BASINS-HSPF results could be improved by substituting data from two NASA data assimilation products: the NLDAS-2 and the "Stage IV 4 km precipitation" derived by the NOAA River Forecast Center Multisensor Precipitation Estimator (MPE). The use of NLDAS precipitation data inputs dramatically improved the water quality model performance over the results obtained when weather station precipitation data were used. In particular, improvement was noted in the summer, when storm events are the primary source of precipitation. A article about this work, "NASA-Modified Precipitation Products to Improve US EPA Nonpoint Source Water Quality Modeling for the Chesapeake Bay," was recently published in the Journal of Environmental Quality. More information and references can be found at the GES DISC News site at [http://disc.sci.gsfc.nasa.gov/hydrology/gesNews/ges\\_disc\\_basins\\_project](http://disc.sci.gsfc.nasa.gov/hydrology/gesNews/ges_disc_basins_project)

### Support NLDAS for BASINS applications

The Better Assessment Science Integrating Point & Nonpoint Sources (BASINS), created by US EPA, is a multi-purpose environmental analysis tool.



Collaborated with BASINS Project, NASA GES DISC has made the NLDAS precipitation data available via the BASINS download tool. To enable the downloading of 30-year time series of hourly NLDAS precipitation data via a single request, the NLDAS GRIB files were parameter and spatial subsetted, archived in a way optimized for time series retrieval, and incorporated into GDS.

With the access via BASINS, NLDAS precipitation data can be easily analyzed and intercompared with other hydrological data in BASINS.

## Conclusions

- All NLDAS and GLDAS data are accessible from the Hydrology Data and Information Services Center (HDISC) at the NASA GES DISC (<http://disc.sci.gsfc.nasa.gov/hydrology>).
- The GLDAS-2 NOAA monthly and 3-hourly data have now been released to the public. GLDAS-2 data from other models will be available soon.
- With the extended temporal coverage (Jan. 1948 – present), the GLDAS-2 data are expected to play an even more important role in global hydrology and climate studies.
- The NLDAS-1 data (Aug. 1986 – Dec. 2007) were recently added to the GES DISC to continue to serve users of NLDAS-1 data, and to allow easier comparisons between the two phases of NLDAS.
- HDISC Science Focus Portal, <http://disc.sci.gsfc.nasa.gov/hydrology/additional/science-focus>, provides NLDAS and GLDAS application examples.
- NLDAS-2 monthly data will be available soon.
- Giovanni online visualization and analysis for 3-hourly GLDAS and hourly NLDAS are coming soon.